Xcel Energy®
RESPONSIBLE BY NATURE™

1800 Larimer St., Suite 1300
Denver, Colorado 80202

August 19, 2016

VIA ELECTRONIC MAIL AND OVERNIGHT MAIL
Joe Castro, Facilities and Fleet Manager
Department of Public Works
1720 13th Street, PO Box 791
Boulder, CO 80306
castroj@bouldercolorado.gov

RE: Voluntary Cleanup Plan Second Interim Remediation Report, dated July 7, 2016 for the 13th Street Plaza Site

Dear Mr. Castro:

Public Service Company of Colorado ("PSCo"), an Xcel Energy Company, appreciates the opportunity to review the Voluntary Cleanup Plan Second Interim Remediation Report, dated July 7, 2016, prepared on behalf of the City of Boulder ("City"). Below are some comments for the City's consideration. Please note that PSCo did not receive the report until on or about August 3, 2016, and did not have a full thirty days to develop comprehensive comments. However, below are some key issues for your consideration that we have identified during our limited review time. Our failure to comment on other aspects of the report does not reflect PSCo's approval or concurrence of those aspects. We look forward to meeting with you later this month to discuss next steps in this matter.

1. The pilot study did not allow for the full evaluation of design parameters.

The Voluntary Cleanup Plan Second Interim Remediation Report (the Report) listed seven items to be evaluated as part of the pilot study (Section 2.0 of the Report). However, the Report did not thoroughly discuss the results of the pilot study with respect to all of these items. The primary conclusions of the pilot study were that small quantities of injection solution can be gravity fed and pumped under minimal pressure (<3 psi) into the trench and that hydrogen peroxide can oxidize organic compounds in groundwater. Injecting small quantities of solution is possible in all but the least permeable of formations. Gravity feed and low pressure injections into backfill material is unremarkable in its achievement. Chemical oxidation of VOCs and SVOCs, including by hydrogen peroxide, is well documented and does not need further field validation. The report does not address issues that do require validation such as radius of influence, distribution of injection solution along the length of the trench, oxidant mass required, and in-situ reaction kinetics. Thus, certain data that will support full-scale design and implementation was not collected, evaluated, or discussed in the report, allowing for the evaluation of key data design parameters.

One important concern about the pilot study relates to the location of the monitoring wells used in the pilot study. The primary monitoring wells used to evaluate effectiveness of the test (MW-3R, MW-8R, and MW-12) are all located outside of the immediate radius of influence based on the injection volumes and have limited value for obtaining design-related data. Additional monitoring points spaced

both along the length of the trench and at stepped distances from the trench, as well as a more comprehensive monitoring program, would have provided far more useful information.

Another concern is that the pilot study utilized horizontal trenches that were installed on the east and west sides of the former Relief Holder. Other than one questionable baseline sample from the well inside the former Relief Holder footprint (MW-12), there is no groundwater data to suggest that this area specifically required additional injections through the horizontal trenches. In contrast, the 2014 Interim Voluntary Cleanup Remediation Summary Report noted that residual impacted soil was located near the Teahouse patio and north and south of the Relief Holder, neither of which were targeted by the horizontal trenches. The use of the horizontal trenches themselves also limits the potential useful data that could be obtained from the pilot study. Future injections will likely be completed using traditional vertical injection points or wells, and applying results from horizontal injection trenches to vertical injection points is limiting.

The XDD Environmental Remedial Alternatives Analysis, which was conducted after the pilot study, evaluated hydrogen peroxide as a potential remedial alternative, but eliminated it from future consideration due to many of the same concerns and limitations raised by PSCo when the concept for the pilot study was first presented in the 2014 Voluntary Cleanup Plan Interim Remediation Report. Some of these concerns include:

- Rapid reaction kinetics of hydrogen peroxide result in limited reactive transport, and hence limited treatment radius. XDD noted that hydrogen peroxide's fast reaction time and short half-life greatly affect its availability for contact, which is a concern for sites such as the 13th Street Plaza Site.
- Off-gas formation and pressurization of the formation. XDD noted gas evolution can temporarily reduce permeability and increase surface pressures, which potentially increase the daylighting of injection solution. This was evidenced during the pilot study by field observations of injection solution surfacing under minimal injection pressures (<3psi).

2. The pilot study was not performed according to the proposed plan.

The 2014 Interim Voluntary Cleanup Remediation Summary Report describing the proposed pilot study noted that a confirmatory bench-scale study was to be performed to validate the planned approach. However, a confirmatory bench-scale study was not performed prior to the pilot study. A bench-scale treatability study was performed by XDD *after* the pilot study was conducted in the field. It should be noted that the bench-scale treatability test was performed using activated and un-activated sodium persulfate, and a subsequent remedial alternatives analysis stated that hydrogen peroxide was not recommended for use at the site.

The proposed pilot test plan stated that approximately 2,000 gallons of 5% hydrogen peroxide solution would be injected into Trench 1. However, only 620 gallons were injected into Trench 1, while 1,510 gallons were injected into the downgradient Trench 2. In addition, the proposed monitoring program included collecting field parameter data for up to four days after injection. However, the last field parameter data was collected less than one day after ceasing injection. It is unclear from the report why the pilot study plan was not followed in the field.

3. There is insufficient information to conclude that the pilot study was effective.

The Report concludes the pilot test was "somewhat effective at reducing MGP-related dissolved-phase VOC/SVOC concentrations", based primarily on groundwater monitoring results for MW-3/3R and MW-12, while discounting the results for MW-8R. It should be noted that only 620 gallons of hydrogen peroxide solution was injected upgradient of MW-12, and approximately 1,510 gallons were injected downgradient of MW-12. There are other potential explanations for the decrease in concentrations that are not associated with the limited injection of hydrogen peroxide solution.

Only one baseline sample was collected from MW-12 prior to performing the pilot test. Typically, four samples are collected from a new monitoring well to establish baseline conditions. A single sample assumes that the monitored condition is representative of stable conditions prior to the pilot test, which may not have been the case. Relying on a single data point also makes the assumption that well development completely removed any contaminants introduced or formation materials loosened during the drilling process, and the well is immediately producing water representative of the surrounding formation. The data from numerous wells installed by USA Environment show that naphthalene concentrations drop significantly from the first to the second sampling event, despite the lack of any remediation or pilot test efforts occurring between the events. Examples include MW-13, MW-14, MW-15, and MW-16. All but MW-13 were installed after the pilot test, and MW-13 is located on an adjacent property a considerable distance from the pilot study area. Two of the wells (MW-14 and MW-15) were upgradient of the pilot test area and outside of the limits of any excavation. All of these wells showed significant decreases in naphthalene concentrations from the first to second sampling events. For example, the naphthalene concentration in MW-15 decreased from 2,900 ug/L to 260 ug/L from the first to the second monitoring event.

Furthermore, concentrations of constituents of concern in groundwater showed significant increases following site investigation and remediation activities in 2012 and 2014 that disturbed site soils (see Comment 4). Concentrations in these wells decreased after the initial spike that followed site disturbance activities. The high concentrations in the first groundwater sample from MW-12 followed by a sharp decrease in concentrations may also be partially attributable to the spike in dissolved phase contamination seen in other wells at the site, and the decrease may be partially attributable to groundwater stabilizing to pre-disturbed conditions.

The naphthalene concentrations in the monitoring wells located approximately 45 feet upgradient (MW-11) and approximately 30 feet downgradient (MW-8R) were below BWSG prior to the pilot study, and were substantially less than the initial concentration in monitoring well MW-12. For the reasons stated above and evidenced by naphthalene concentrations in adjacent wells, the initial naphthalene concentration in MW-12 is suspect and the subsequent decrease in concentration may be a result of numerous influences other than the injection of 620 gallons of hydrogen peroxide solution upgradient of the monitoring well.

The Report also suggests that the reductions in naphthalene concentrations in well MW-3R between the baseline (7,700 ug/L) and second monitoring event (4,800 ug/L) are a result of the pilot test injections. However, well MW-3R is reportedly located 55 feet downgradient of Trench 2. The second sampling event took place less than three days after the injection into Trench 2. In order for the pilot study to have had an effect on MW-3R by this time, groundwater would have to be travelling at a remarkable rate of 18 feet per day or faster. Considering that the backfill placed in this area was lean

clay and sandy lean clay, a groundwater velocity that high is very unlikely. Even if that was the case, groundwater velocity data was apparently not collected as part of the pilot study.

4. The groundwater data indicates exacerbated site conditions.

The report data indicate that the prior investigation and remediation activities on site exacerbated site conditions. Specifically for the wells identified in the Voluntary Cleanup Plan Application identified as point of compliance wells:

- MW-6: Naphthalene was recorded at a concentration of 184 ug/L at the beginning of investigative and remediation activities that disturbed the site. During pipeline removal efforts, numerous spills of liquid from within the pipes were observed upgradient of this well location. Naphthalene concentrations rose to as high as 784 ug/L before decreasing following soil removal activities. Since then, the concentrations fluctuated above and below the Colorado Basic Standard for Groundwater (BSGW) for naphthalene of 140 ug/L. The naphthalene concentration from the most recent sample result is below the BSGW at a concentration of 52 ug/L.
- MW-7: Naphthalene concentrations in MW-7 were below the BSGW for all five sampling events conducted prior to soil removal activities, with a low concentration of 21.7 ug/L. Following soil removal activities, the naphthalene concentration in MW-7 increased to 590 ug/L before subsequently decreasing. However, sample results from only one sampling event (parent and duplicate sample) were below the BSGW. Naphthalene concentrations for all remaining sampling events, including the most recent, were above the BSGW. The naphthalene concentration from the most recent sample result was 147 ug/L.
- MW-10: This well was installed after the pipe removal activities. Two of the first three samples from this well were below the BSGW for naphthalene. Following soil removal activities, the naphthalene concentrations rose above the BSGW for 6 consecutive events, with a peak of 6,150 ug/L (duplicate sample). The two most recent sample results for naphthalene were below BSGW, and the most recent concentration for naphthalene was 9.6 ug/L with a duplicate of 10.6 ug/L.

In addition to the point of compliance wells, naphthalene concentrations in the original and replacement wells MW-3/MW-3R are notably higher after completing investigation and remediation efforts that disturbed the site. The naphthalene concentrations at the start of these activities was 371 ug/L and 341 ug/L (parent and duplicate samples). Naphthalene concentrations rose to as high as 7,700 ug/L following soil excavation activities. Naphthalene concentrations have decreased, but remain well above the BSGW. The naphthalene concentration from the most recent sample result was 2,790 ug/L.

5. There is not an adequate analysis of alternatives or the proposed full scale in-situ work.

The alternatives in general are not fully developed or analyzed. Alternative 1 and Alternative 2 are both only discussed for one page each, while Alternative 3 is discussed for approximately 4.5 pages. Furthermore, each evaluated alternative should not be limited to a single technology. A combination of technologies may be used in sequence, or different alternatives may be considered for separate areas of the facility. For example, enhanced in-situ bioremediation could be used to target residual impacted soil located near the Teahouse patio and north and south of the Relief Holder and monitored natural attenuation (MNA) could be used outside of these areas.

In addition, MNA was not mentioned in the preliminary identification and screening of remedial technologies and was not developed as a remedial alternative for evaluation in the XDD Remedial Alternatives Analysis. Natural attenuation was simply merged with no further action. No further action should be developed and evaluated separately from all other alternatives, including MNA or combinations of alternatives that include MNA. The EPA has recognized that MNA may be an appropriate remediation option for contaminated soil and groundwater under certain circumstances, and suggests that MNA should be evaluated along with other viable remedial approaches or technologies within the applicable remedy selection framework. Furthermore, the CDPHE Voluntary Cleanup Roadmap notes that for groundwater remediation, "The applicant may treat the entire plume, or may perform remedial actions only within the property boundary, and rely on monitored natural attenuation for the remainder of the plume." The guidance document goes on to state, "If the entire plume is not treated, an evaluation of monitored natural attenuation must be made."

The concept of natural attenuation was described in the Remedial Alternatives Analysis as being "very slow" and the timeframe to achieve applicable or relevant and appropriate requirements (ARARs) was noted as "likely greater than 100 years". However, there is no evaluation of actual site groundwater data to support that notion or to determine if MNA was a viable alternative. Data that suggests attenuation processes include naphthalene concentrations in MW-5 decreasing from 2,050 ug/L to below the BSGW prior to the excavation activities. Similarly, naphthalene concentrations in MW-13, MW-14, MW-15, and MW-16 have all shown consistent decreases since installation. Naphthalene concentrations in MW-13 and MW-15 began above the BSGW, but have since decreased to below the standard. With the exception of MW-16, these wells were installed outside of the main remediation and pilot testing areas. The Remedial Alternatives Analysis suggests that there is no significant short-term effectiveness associated with natural attenuation; however, the site data suggest otherwise.

Similar to natural attention, the Remedial Alternatives Analysis assumes that enhanced in-situ bioremediation is "very slow" and that it would "take a long time" to achieve ARARs. There is no information to support this claim, and no evaluation of exposure pathways or the potential effects on human health and the environment in the timeframe required to achieve remedial goals.

Finally, institutional controls were not discussed in the Remedial Alternatives Analysis. Based on the cursory information provided, we cannot comment fully on the proposed next steps, and respectfully request the opportunity to review a fully developed work plan describing the scope for any additional proposed remediation activities.

6. The groundwater wells may not have been properly developed.

The Report text states the new wells were either surged and purged with a surge block and bailer or pumped with a Whale® pump. The field monitoring well development logs show that a bailer was only used for development of one well (MW-16). The remainder of the wells, with the exception of MW-3R, were developed with a Whale® pump. The method for development for MW-3R was not provided. Based on CDPHE Standard Operating Procedures, development is best accomplished by surging. Standard industry practice is to alternately surge and purge a monitoring well. Development by pumping only can lead to development of the most permeable interval first, after which water will preferentially flow through this interval and the rest of the screen will remain poorly developed.

One of the most important parameters to measure during development is turbidity. CDPHE notes that wells are considered developed when the groundwater turbidity has diminished to an acceptable level. Turbidity can be measured in existing wells on site to establish acceptable levels for development. The field forms list turbidity measurements as "high", "↑", "med", "mod", "low", and "clear", but actual numerical values are not recorded. Turbidity meters are common groundwater sampling equipment, either combined as a multi-parameter probe or as a standalone unit. The meters would produce numeric values that should have been documented on the field forms instead of using qualitative descriptions. Dissolved oxygen and oxidation reduction potential are also listed as parameters on the field monitoring well development log, but measurements for these parameters were not collected.

Specifically for the monitoring wells used to evaluate effects of the pilot study:

- MW-3R: A total of 30 gallons were removed from this well. The method of development is unknown. Turbidity was initially listed as "high", and then listed as "med" for removal of water from 13 gallons thru 30 gallons.
- MW-8R: The well was pumped dry after 1.25 gallons and no further attempts were made to develop the well. Turbidity was listed as "mod."
- MW-12, the well was pumped dry after 6 gallons and no further attempts were made to develop the well. Turbidity was listed as "mod."

Incomplete development can lead to residual introduced contamination or loosened fines from drilling being pulled in during sampling activities. Contaminants can also be introduced during well development. Higher molecular weight polycyclic aromatic hydrocarbons (PAHs) that have lower solubility have tendency to sorb to soil particles, and samples with high turbidity can produce artificially high concentrations in a groundwater sample. The final turbidity readings for the three wells above are listed as either "mod" and "med." Groundwater sampling field forms were not provided that indicate sampling techniques or whether turbidity was high or low during the sampling events.

7. The information is incomplete or otherwise difficult to discern.

The majority of the data is contained within large tables and is not succinctly presented for interpretation. For example, only one groundwater elevation map is provided, but up to seven rounds of water level data are presented in Table 3 that were collected after the 2014 Interim Voluntary Cleanup Remediation Summary Report was submitted. At a minimum, semi-annual groundwater elevation maps should be provided to help the reader to discern changes in groundwater flow after soil removal activities. Additionally, there is no mention in the text of results from soil samples collected after the 2014 Interim Voluntary Cleanup Remediation Summary Report was submitted, and there is no presentation of results on figures to allow spatial interpretation of the data. A final example is the presentation of groundwater data on Figure 5. The figure presents data from June 2015 through March 2016; however, up to three additional rounds of samples were collected after the 2014 Interim Voluntary Cleanup Remediation Summary Report was submitted and are not shown on the figure. We suggest including time vs. concentration graphs showing water quality data for the entire period of record for monitoring wells to allow interpretation of groundwater quality trends.

In order to evaluate the pilot study, the following information is needed, but not provided in the report:

- A written interpretation of the groundwater contour map is needed.
- A written discussion of current groundwater flow direction compared to pre-excavation groundwater flow direction is needed.
- An explanation for the significant changes in the measured total depth of monitoring wells MW-3R and MW-11 from 2014 to 2016.
- It is unclear how field measurements were taken in adjacent wells during the pilot study.
- A description of the groundwater sampling techniques and copies of the groundwater sampling forms.

8. Quarterly groundwater data is not being collected but should be collected.

The VCUP application suggested that groundwater monitoring at point of compliance wells will be initially performed on a quarterly basis for up to two years, followed by semi-annual sampling, as needed, to confirm a stable or declining trend in COC concentrations at the site. Although less than two years of quarterly data has been collected and stable or declining trends in COC concentrations have not been established, the report suggests that groundwater monitoring is not currently being performed and will not restart until after the selected alternative is implemented.

9. General concerns about overall remediation approach.

We continue to have concerns about the overall investigation and remediation approach at the site as previously expressed in prior feedback shared with the City. We have been concerned that a more targeted approach to removal/excavation, and one that took into account contingency measures to prevent potential releases, would have been advisable, as it would have achieved protection of human health and the environment, consistent with industry practices and CDPHE's and EPA's policies to design risk-based approaches for remediation, without exacerbating site conditions and unnecessarily increasing project costs. Given current site conditions, we understand the City intends to implement further in situ treatment. If so, we recommend that the issues identified herein be addressed to more fully evaluate the effectiveness of the planned future injections and potential alternatives.

Thank you for consideration of these issues.

Sincerely,

Quinn V. Kilty
Manager, Environmental Services
Public Service Company of Colorado